PROPOSAL FOR THE RECLASSIFICATION OF MORELET'S CROCODILE (*Crocodylus moreletii*) IN THE ENDANGERED SPECIES ACT (ESA) OF THE UNITED STATES OF AMERICA

Presented by Mexico

SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES | SEMARNAT

CONABIO

Comisión Nacional para el Conocimiento y Uso de la Biodiversidad

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Foreword

Since the middle of the 90s, Mexico stated the need to update the status of Morelet's crocodile (*Crocodylus moreletii*) in the Endangered Species Act (ESA) of the United States of America. This, due to the fact that Morelet's crocodile populations have shown clear signs of recovery and experts consider that the species no longer meets the criteria for being classified as Endangered.

Since the beginning of 2000, Mexico's National Commission for the Knowledge and Use of Biodiversity (Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, CONABIO) started compiling and generating information concerning the current status of Morelet's crocodile wild populations in order to uphold the experts' opinion that the species is no longer endangered.

During the VII Meeting of the Canada-Mexico-US Trilateral Committee for Wildlife and Ecosystem Conservation and Management (Nuevo Vallarta, Mexico 2002), CONABIO presented a review of the status of *C. moreletii* wild populations, based on a rapid assessment developed by the Technical Advisory Subcommittee for the Conservation, Management and Sustainable Use of the Crocodylia in Mexico (Subcomité Técnico Consultivo para la Conservación, Manejo y Aprovechamiento Sustentable de los Crocodylia en México; COMACROM) and financed by CONABIO. During this meeting, the U.S. government expressed the need to have more information on wild populations in order to consider the transfer or removal of the species from the ESA.

In order to obtain such information, CONABIO requested COMACROM, through the Natural History and Ecology Institute of Chiapas (Instituto de Historia Natural y Ecología de Chiapas; IHNE), to develop a study aiming to evaluate the current status of the species' wild populations. The study, entitled "Determination of the status of the wild populations of Morelet's crocodile in Mexico, and evaluation of its status in CITES", started at the beginning of 2004 and was coordinated and financed by CONABIO.

At the end of 2004, the report containing the final results of the study was delivered. With the aim of discussing and analyzing the field data contained in this report and all the available information on the species, CONABIO organized an expert workshop. The main objective of the workshop was to evaluate the appropriateness and viability of reclassifying the species in the ESA.

The workshop participants included internationally renowned academics, biologists with expertise in both ecology and herpetology, members of the IUCN-SSC Crocodile Specialist Group, COMACROM, government staff from the Mexican CITES Authorities (Wildlife Division of the Ministry of the Environment: Dirección General de Vida Silvestre, DGVS-SEMARNAT; Law Enforcement Authority: Procuraduría Federal de Protección al Ambiente, PROFEPA; and CONABIO), the National Institute of Ecology (Instituto Nacional de Ecología, INE), commercial breeders, and others interested in the conservation of the species. The workshop was organized and financed by CONABIO, and was held in its facilities on December 1st and 2nd of 2004.

After reevaluating the current status of *C. moreletii* under the criteria of the ESA, the Risk of Extinction Evaluation Method included in the Mexican Official Norm of species at risk (NOM-059-SEMARNAT-2001), and the IUCN's Red List of Threatened Species, the results showed that the species no longer qualifies to be under any risk category.

Under this evaluation, it was decided that delisting the species from the ESA was appropriate and thus we identified and compiled the information needed to prepare a proposal to be presented during the X Meeting of the Trilateral Committee (Zacatecas, Mexico 2005).

Based on the results and the information derived from the workshop, CONABIO asked an external consultant, Oscar Sánchez -a well-known Mexican scientist with expertise in wildlife management and conservation- to carry out the necessary analyses and to prepare the final proposal.

On the basis of the above, the present document represents a formal petition from the Mexican Government to the Secretary of the Interior of the United States of America, and the Secretary of Commerce to remove Crocodylus moreletii from the list of the Endangered Species Act. This proposal contains scientific, conservation, and commercial information and evidence in support of this argument.

Six annexes are included in this petition; these contain complementary information about risk assessment under two systems distinct from the ESA, pertinent field data, and additional information on the species conservation actions in Mexico.

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Acknowledgements

CONABIO would like to thank the following persons for their collaboration and important contributions to the development of this proposal. With their participation, the compilation of information concerning the relevant aspects of *Crocodylus moreletii*, both in the country and in the rest of its distribution area, was possible. We would like to particularly thank Oscar Sánchez for having carried out an exhaustive analysis of all the information and for having developed a solid and well-supported proposal to reclassify the species in the ESA.

Jerónimo Domínguez Laso (Zoológico Regional "Miguel Álvarez del Toro, Instituto de Historia Natural y Ecología), Luis Sigler Moreno (Independent researcher), Oscar Hinojosa Falcón (Instituto Tecnológico de Ciudad Victoria), Hesiquio Benítez Díaz, Jorge Álvarez Romero, and Paola Mosig Reidl (Dirección de Enlace y Asuntos Internacionales, CONABIO), Jesús Alarcón and Sonia Careaga (Dirección de Análisis y Prioridades, CONABIO), Norma Moreno (Subdirección del SIG, CONABIO), Oscar Ramírez Flores and Leonel Urbano Gutiérrez (Dirección General de Vida Silvestre, SEMARNAT), Paloma Carton de Grammont Lara (Dirección General de Investigación de Ordenamiento Ecológico y Conservación de los Ecosistemas, INE), Alvaro Velasco B. (Latin American and the Caribbean Region Crocodile Specialist Group IUCN/SSC), James Perran Ross (Crocodile Specialist Group IUCN/SSC), Paulino Ponce Campos (COMACROM), Adrián Reuter Cortés (TRAFFIC Norteamérica), Manuel Muñiz Canales (COMACROM), Hiram Barrios Rivera (Dirección General de Inspección de Vida Silvestre, PROFEPA), Gustavo Casas Andreu (Instituto de Biología, UNAM), Xóchitl Aguilar Miguel (Facultad de Ciencias, UAM), Alejandra García Naranjo (Unidos para la Conservación, A.C.), Francisco León Ojeda (Cocodrilos de México S.A. de C.V.), Rodrigo Medellín Legorreta (Instituto de Ecología, UNAM), Oscar Fernández (COMAFFAS).

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I. Introduction

International cooperation between Mexico and the United States of America, for the conservation and sustainable use of biodiversity, is now a tradition for both countries. Activities in this respect span a growing number of topics, which calls for an ever-growing enhancement of communication, and for permanent updating of the common agenda.

In this context, the Mexican government presents its American counterpart a proposal for the removal of Morelet´s crocodile (*Crocodylus moreletii*), also known as swamp crocodile, from the list of endangered and threatened species of the Endangered Species Act (ESA).

Recent availability of new field information on *C. moreletii* and its wild habitat in Mexico (2002–2004), as well as of results of analyses based on it, and of static and dynamic population modeling, indicate the need for an update of the category of this species in the U.S. ESA. This recent evidence also supports the process of quinquennial revision of the species list, as provided by the ESA itself.

The present petition responds to a need for homogeneity in the real status designation of *C. moreletii* among the various systems of risk and protection categorization, both at the global (IUCN, CITES) and national levels (*i.e.* NOM-059-SEMARNAT-2001, Mexico; and the ESA). The petition also departs from the need to reinforce the strategy, put forward by Mexico, for the conservation of this species and its habitat, based on the ban of commercial capture in the wild and, in a synergetic way, on encouraging the already significant captive reproduction of *C. moreletii*, from egg to adult stage. This whole-cycle captive reproduction occurs within an ample basis of legal regulation and administrative control, and seeks to maintain an additional stock of the species, as well as to stimulate really sustainable commercial activities that give direct support to conservation.

II. Background

Crocodylus moreletii is a crocodile whose geographic range comprises the slopes of the Gulf of Mexico, from Tamaulipas to the Yucatan Peninsula, Belize and northern Guatemala. Its range in Mexico represents about 85% of the total geographic area it occupies. (See map 1. Distribution of *C. moreletii*)

Until the middle of the XX Century, commercial utilization of this species was not subject to control in Mexico, Guatemala, and Belize. As a consequence, in 1970 concern about the natural populations had increased considerably. This motivated Mexican authorities to decree a total and permanent official ban to the commercial capture of wild individuals.

In general, the inclusion of *C. moreletii* in the immediate forerunners of the Endangered Species Act in June 2, 1970 as an Endangered taxon (*E*) is considered also a consequence of the same concern on the part of the United States of America. That measure gave effective support to Mexico's policy in the 1970´s for the protection of *C. moreletii*, since it acted in synergy with the Mexican ban, also passed in 1970.

Map 1. General distribution of *C. moreletii.*

By the time of installation of the ban in Mexico, and in support of it, the Mexican government initiated actions for conservation decreeing several natural protected areas, and encouraging captive breeding projects dealing with this crocodile. Some official captive breeding facilities opened and, also, in Chiapas –an emblematic State in the distributional area of *C. moreletii*– joint efforts by the World Wildlife Fund (WWF) and the Instituto de Historia Natural del Estado de Chiapas, materialized in a special breeding program started in 1973, aiming to restock wild populations in southeastern Mexico with offspring of this species reared in captivity.

These efforts sowed, some 30 years ago, the seed of a real possibility of recovering this crocodile species, which since the late XIX to the middle XX Centuries, was intensely hunted for commercial purposes and that originated a severe –though fortunately reversible– decline of wild populations.

Measures for legal protection and law enforcement, as well as for captive breeding (grossly between 1970 and 2000), doubtlessly modified the condition of the species in Mexico. However, for several years results were not objectively known, since adequate and ample-coverage field surveys had not been made, and other local results were not available. Even so, several Mexican and recognized international specialists expressed, in the last part of the XX Century, their perception that the status of *C. moreletii* in the wild had significantly improved. These expert opinions were mainly based on local evidence and, in some aspects, also on information of a regional scope. Seemingly, despite the complexities and difficulties of effectively implementing a ban, that of 1970 in Mexico did produce positive results.

In 1995, during a technical visit by Dr. James Perran Ross (Executive Secretary of the IUCN-SSC Crocodile Specialist Group) to the natural geographic area of the species, with

an emphasis on Mexico, new opinions on the conservation status of *C. moreletii* were produced. These were provided by several local experts with data then available for Mexico, but also for Guatemala and Belize. On the basis of these opinions and data, J. Perran Ross concluded that considering *C. moreletii* as an endangered species would no longer would be justified.

From 1986 to 2005, the general perception about the global risk status of *C. moreletii* has experienced considerable changes. Originally -1982- it was considered as Endangered (EN according to IUCN categories). In 1994, IUCN introduced new criteria for the evaluation of species and, recognizing that there was insufficient data to evaluate its status, *C. moreletii* was assigned to the Data Deficient (Dd) category (IUCN Red List 1996). In May 1996, at an international working meeting in Santa Fe, Argentina, the IUCN-Crocodile Specialist Group convened a group of experts who compiled the more recent information and recommended the status of Lower Risk- conservation dependent (LR-cd) (Ross 1996) and this change was accepted in the 2000 IUCN Red List. Currently (2005), IUCN continues to include *C. moreletii* in this category. Among the several facts that drove CSG to recommend this status were current reports from Mexico that the species remained present in all its recorded localities and most expert opinion pointing to the conjecture that the wild adult population might include in excess of 10,000 individuals.

Thus, a noticeable improvement of wild populations of *C. moreletii* had become *vox populi* but until recently no systematized information was available for most of the geographic range of the species, at least not in enough detail as to allow for a more substantiated assessment.

III. Basis of the petition

Starting in 2000, an intense effort has been applied in Mexico for a more informed assessment of the conservation status of the swamp crocodile or Morelet's crocodile (*Crocodylus moreletii*) and of the environment of international cooperation about this topic. As a result, today it is evident that:

- Field data on *C. moreletii* are now available in an unprecedented amount for Mexico, resulting from vigorous surveying effort between 2002 and 2004 in representative portions of the whole distributional range of the species in this country.
- Results of scientific analyses have been produced, based on that information pertaining to the wild population and its habitat, on specialized published information, and on field reports from areas outside Mexico. These initial results indicate that the global wild population of *C. moreletii* is not currently endangered or even threatened by extinction.
- There is evidence that information available for Guatemala and Belize would support, in general, conclusions recently derived for this taxon in Mexico.
- It seems clear that *C. moreletii* is a species with high resilience since, once commercial capture in the wild was removed, it was able to revert, in just three decades and mostly by itself, a condition of very low population originated by nearly 100 years of overexploitation.

- The effectiveness of official protection granted by Mexico to the species, by means of a robust legal and administrative framework, is demonstrated by the consistent recovery of wild populations. That framework gives certainty about the future of the taxon.

- Mexico has maintained a policy of creation of more natural protected areas, and of active administration of those already in existence, many of which are of direct relevance for the conservation of *C. moreletii*.

- Mexico has created and reinforced an official system (SUMA) based on Units for Wildlife Management and Use (UMAs) for the control and regulation of captive reproduction of *C. moreletii*. The system requires complete reproductive cycle breeding for conservation and commercial use, and guarantees enhancing Mexico's population reserves for the conservation of this crocodile.

- The existence of those captive breeding facilities also keeps an open possibility for sustainable economic development, that further discourages capture from the natural environment. Strict Mexican regulations control commercial activity of captive-bred specimens. This enforces licit and transparent commercial operations, since breeding facilities need to prove that they are able to go beyond the second generation (F2) of reproducing individuals, at least one generation beyond. This is part of the conditions required for commercial use of captive-bred crocodiles and supports a use consistent with conservation. On the other hand, existence of these intensive, closed-cycle captive crocodile farms, offers a bonus in the form of organized eco-tours to the facilities, with no impact on wild populations, but with a potential for economic development, not only of the owners of the farms, but of the human communities in the vicinity based on secondary and subsidiary services to visitors.

- The existence of several wild populations of *C. moreletii*, in places where habitat conditions allow for some predictable visibility of crocodiles, permits to anticipate certain potential for low-impact ecotourism. Optimally, these should be managed by local communities and be mainly oriented towards extending information for conservation among visitors.

- Mexican authorities execute a vigorous law enforcement program in relation to laws applicable to wildlife conservation.

- The Mexican government has a supportive consulting organ, which gives scientific and technical advice on crocodile conservation (Subcomité Técnico Consultivo para la Conservación, Manejo y Aprovechamiento Sustentable de los Crocodylia en Mexico; COMACROM). This Subcommittee includes scientists, non-governmental organizations, private crocodile producers, and authorities.

The quest for increasing congruence and harmony of criteria among the various systems of species categorization, pertaining to the risk extinction of *C. moreletii* both at the national and international levels (in the current knowledge that the species is not imperiled) will facilitate its protection and conservation at the global scale. Considering all the aforementioned arguments, we present the following:

IV. Petition

On the basis of the evidence set forth in the preceding parts of this document, the Mexican government presents the formal petition to the Secretary of the Interior of the United States of America, and the Secretary of Commerce in those aspects applicable according to Section 3(C)(15); ESA (1973), and in compliance with the terms of Section 553(e), Title 5 of the Federal Code of the United States of America, to remove the species *Crocodylus moreletii* from the list of the Endangered Species Act (ESA).

With this petition we aim to update the official assignation of *C. moreletii* with respect to the ESA, under the following status codes:

DM -- Delisted Taxon, Recovered, Being Monitored First Five Years; and

DP -- Delisted Taxon, Discovered Previously Unknown Additional Populations and/or Habitat.

In order to achieve this, satisfying the requirements of Section 4(3)(A) of the document "ESA Determination of Endangered Species and Threatened Species", this petition contains scientific, conservation, and commercial evidence, as well as results of analyses of that evidence, all of this pursuant to the removal of *C. moreletii* from the ESA.

Six annexes accompany the petition; these contain complementary information about risk assessment under two systems distinct from the U.S. ESA, pertinent field data, and additional information on conservation actions in Mexico, as follows:

- Annex 1 - Reevaluation of the risk category assignable to *C. moreletii* under the current criteria of the IUCN.

- Annex 2 - Reevaluation of the current status of *C. moreletii* under the criteria of the official MER (Risk of Extinction Evaluation Method), included in the Mexican Official Norm NOM-059-SEMARNAT-2001.

- Annex 3 – The Mexican legal framework, as related to conservation and sustainable use of *C. moreletii*.

- Annex 4 – List of participants from the technical "Workshop for the review of wild populations status of *Crocodylus moreletii* in Mexico and evaluation of the appropriateness to propose its deletion from the U.S. Endangered Species Act", that was held in CONABIO, Mexico City (December 1 and 2, 2004).

- Annex 5: Raw field data obtained for Mexico by the COPAN Project; the main basis of the various analyses performed.

- Annex 6: Conservation actions in Mexico in support of the continuing recovery of *C. moreletii*

V. Available evidence

V.1. Field surveys in Mexico

Starting in 2000 and extending through 2002 – 2004, and with support from Mexico's National Commission for the Knowledge and Understanding of Biodiversity (CONABIO), Mexico developed the "Swamp Crocodile Project" (COPAN), conducted by Biól. Jerónimo Domínguez–Laso and M.V.Z. Luis Sigler. This project had two objectives:

a) To gather updated field data on the presence and relative abundance of *Crocodylus moreletii* in a representative portion of the whole geographic range of the species in Mexico; and

b) To gather new information suitable for habitat quality assessment in reference to this crocodile species, from a sample of localities widely distributed along its natural range.

Methods applied during the COPAN Project were those commonly accepted worldwide such as nocturnal surveys for crocodiles, along river banks and lake shores, with the aid of lights (Sanchez, 2000), choosing low or high intensity depending on the field conditions and visual-field width in each particular site (J. Domínguez – Laso and P. Ponce, com. pers.). For habitat assessment, a system based on point assignation to five components of the environment was employed. Point assignation was based on current knowledge of the biology of the species, and on the experience of field personnel, and points for each component were ultimately added up (Domínguez – Laso *et al*. 2004; Domínguez–Laso in press). Sampling effort was intensified in the two last sampling periods (dry "A" and rainy "B" seasons of 2004, respectively).

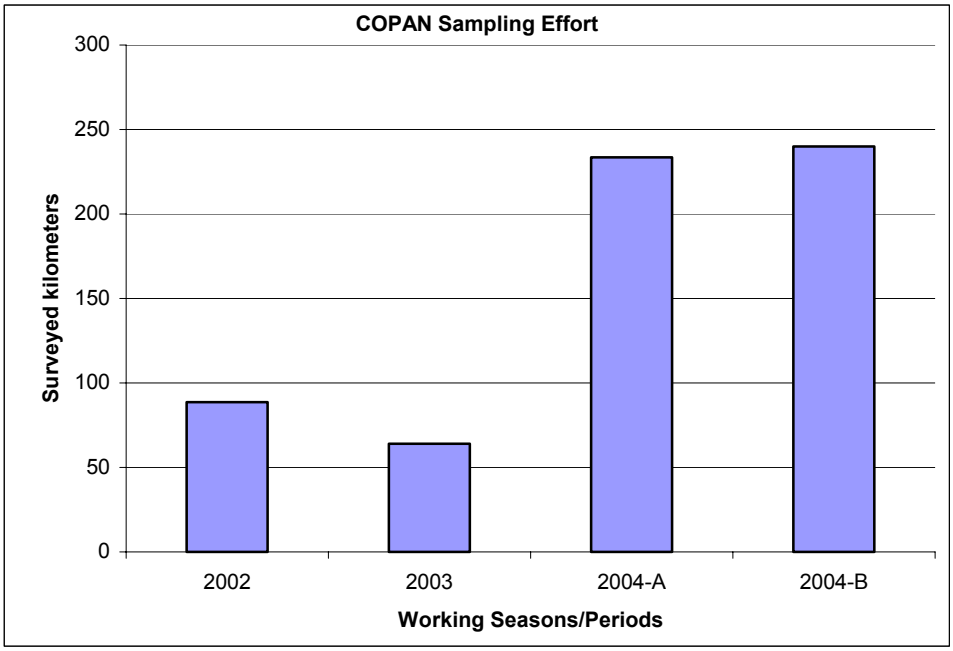
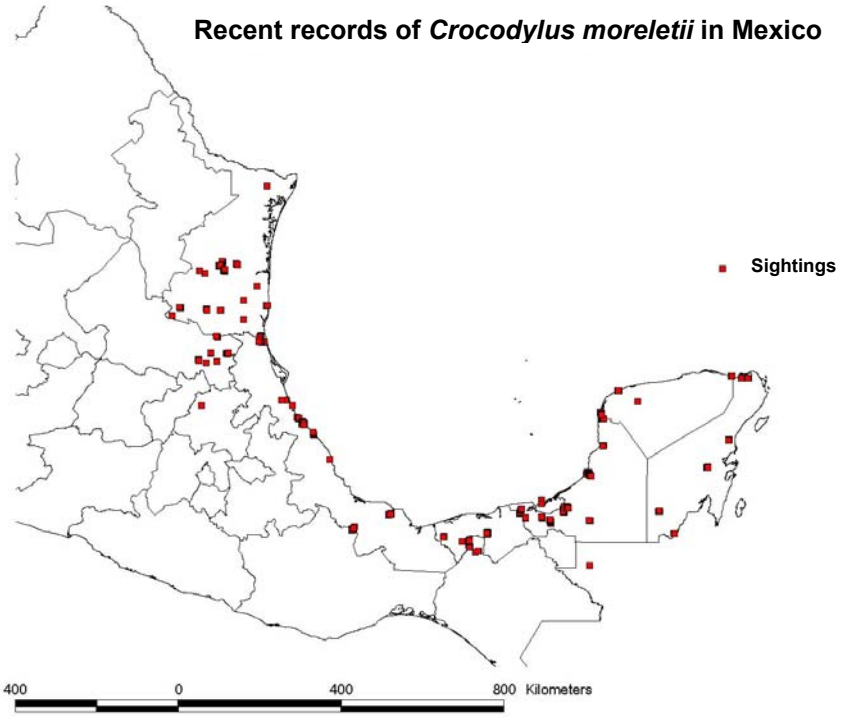


Figure 1. COPAN Project Sampling Effort.

V.1.1. Geographic coverage

The COPAN surveys comprised ten Mexican States, for a total of 63 sampled localities within the whole geographic range of the species (see Map 2, which depicts recent records of *Crocodylus moreletii*).



Map 2. Known localities for *C. moreletii* as of 2004.

Roughly from 1851 to 2002, *C. moreletii* was known from 105 localities in Mexico. The COPAN Project revisited a sample of 21.9% of these (in some cases after 154 years), and found the species present in all of them. Besides verifying the permanence of the species at these historic sites, 40 new localities were added to the gazetteer for *C. moreletii*, including a first state record for Queretaro. All these bring the total number of localities presently known for the species to 145 (Domínguez–Laso *et al*., 2004).

V.1.2. Abundance indices of individuals

With the exception of an extreme case, a locality with an unusually high number of individuals per length unit (38 ind/km), indices of relative abundance of individuals (excluding the cited case) average 5.76 ind/km and have a Mode of 3 ind/km. See Figure 2 (Abundance indices of *C. moreletii* recorded at 63 localities in Mexico).

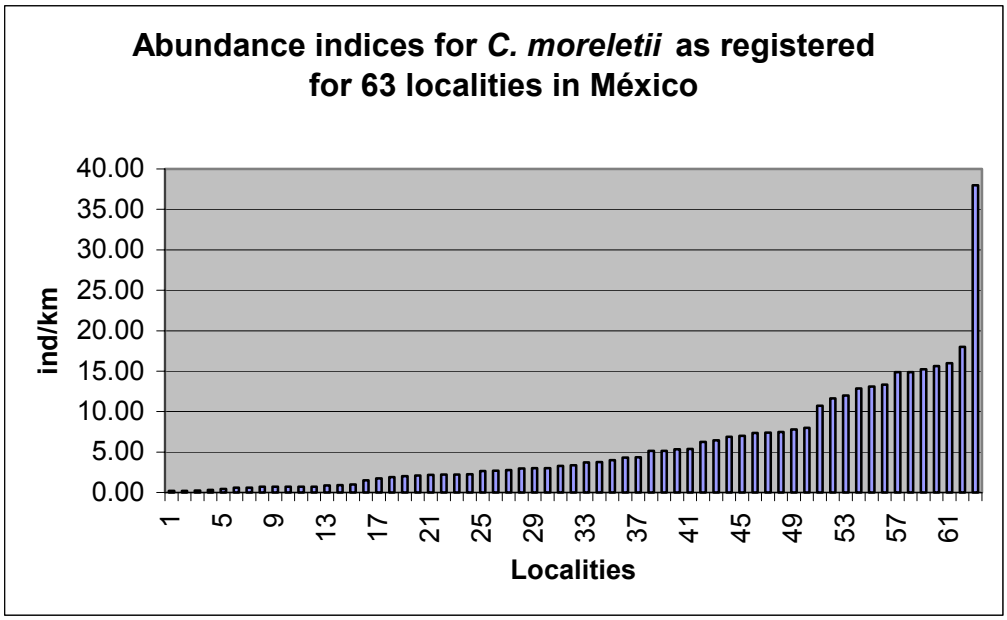


Figure 2. Relative abundance indices for *C. moreletii* as recorded by the COPAN Project (data from Domínguez – Laso *et al*., 2004).

In a combined sample of individuals examined in the field, in Mexico, considered as indicative for the area occupied by the species, 34% were juveniles and 19% adults. Though only indicative, this result is encouraging since the most frequent class was that of juveniles (indicating a good recruitment level), and since adults (*i.e.* potentially reproductive individuals) were not scarce. From an also combined sample of individuals effectively sexed by the COPAN personnel, a sex proportion of 1.55 to 1 was found, biased towards males. This situation is not uncommon in published reports, an extreme was found in Belize, with a 5.3 to 1 proportion, favoring males; not yet explained, but apparently without indication of potential risk (Platt and Thorbjarnarson, 2000).

V.1.3. Habitat quality

In this respect, based on numerical assignation system developed to evaluate five environmental components (relevant to the species concerned), the COPAN Project personnel reported that in 24 (57%) of a total of 42 localities evaluated in various areas of the species' distribution in México, habitat resulted apt for the crocodiles, and in 10 of them (24%) it even resulted excellent. Based on these data, a correlation analysis showed that, apparently, there is no strict relation between habitat quality and the number of observed crocodiles. In fact, COPAN found evidence indicative of continued presence of *C. moreletii* even in localities with intermediate or lesser habitat quality.

Most frequent human activities, as reported by the COPAN field parties for those areas where crocodiles were seen between 2002 and 2004 were, in descending order of importance: fishing, livestock rearing, self-consumption hunting, conventional tourist facilities, agriculture, ecotourism, industry and urban development. Environmental changes such as those related with fishing and livestock rearing would appear as the least disturbing for *C. moreletii*, while others like industry and urban development would seem to be the most negative.

V. 2. Potential distribution, and estimated magnitude of the potential global population

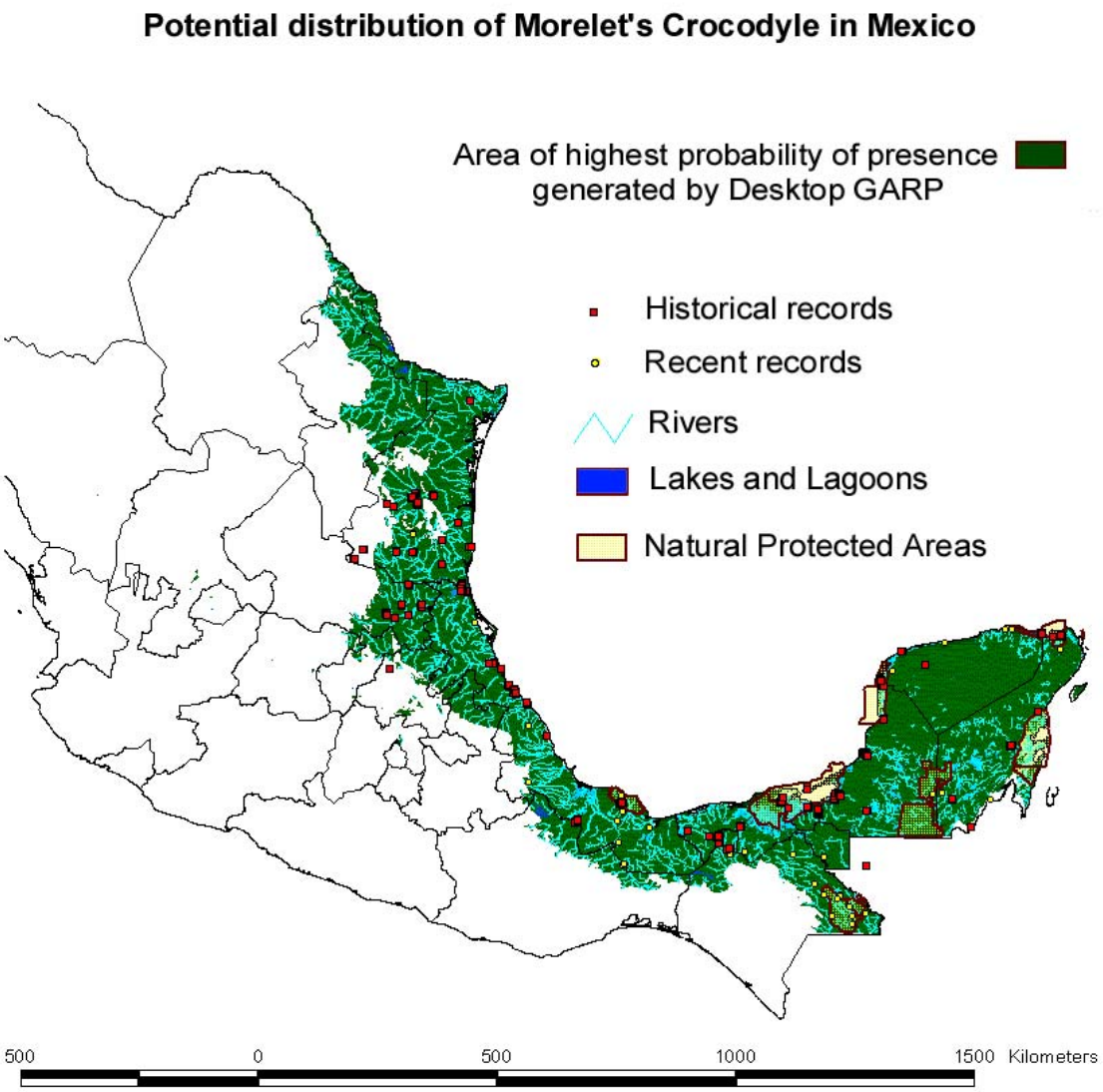
Taking geographic data, field data reported by the COPAN Project, and some published information available for Guatemala and Belize, Prof. Oscar Sánchez, the specialist in charge of the analyses, first applied a static model he had previously developed for attempting an initial estimation of the potential global population of *C. moreletii* (Sánchez, in press $_{(a)}$; Sánchez, in press $_{(b)}$), as explained below:

V.2.1. Potential distribution of *C. moreletii* in Mexico

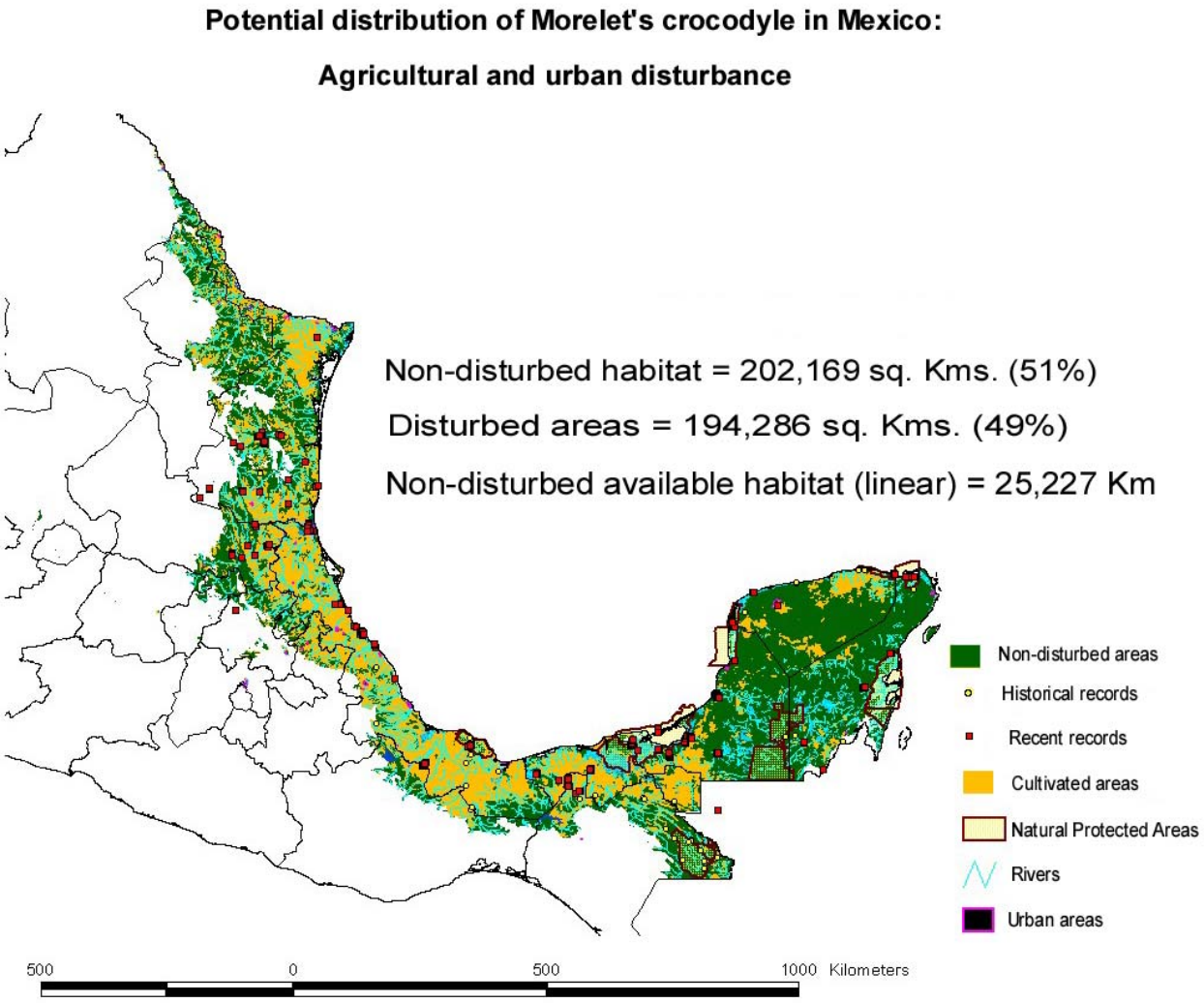
For Mexico and with support of the computational infrastructure present at CONABIO, by means of the Desktop GARP software (Genetic Algorithm for Rule-set Prediction), a map of the area of highest probability of presence of *C. moreletii* was generated. The map was based on several environmental factors known for the recorded localities. The GARP area of highest probability resulted of 396,455 km^2. Then, for the area thus generated, total length of rivers, and perimeters of freshwater lagoons and other water bodies were calculated with the aid of a Geographical Information System (GIS); this generated a first figure for potential habitat length of 106,707 km. Later on and as a first precautionary cut, shore lengths of intermittent water bodies were removed from the initial count, leaving only lengths of those documented as perennial. This resulted in 49,465 km. (see Map 3, Potential distribution of *C. moreletii* in Mexico). As a second cautionary cut to avoid undue overestimation, only the simple length of rivers was considered, entirely ignoring an equal length that would have been added if the opposite bank was also considered (despite the fact that it really exists and means additional potential habitat).

In order to produce an even more precautionary habitat estimation, a third cut was applied: the area actually altered by agricultural and cattle-raising activities was substracted from the total GARP area. This resulted in an approximately 51% of the area still retaining original vegetation types (*i. e.* 202,169 km^2). By analogy, applying the 51% proportion of conserved habitat to the previously obtained lineal measurements for perennial freshwater shorelines, it was inferred that at least 25,227 km would hold habitat suitable for *C. moreletii* in Mexico. This figure was utilized as potential habitat in the country, during subsequent calculations.

Since the COPAN Project has reported evidence of the persistence of crocodile populations even in altered areas, most probably the procedure of successive potential habitat length cuts means significantly underestimating real habitat length for *C. moreletii* in Mexico, but this option was preferred to keep a precautionary perspective throughout the analyses. (See Map 4, Potential distribution of *C. moreletii* in Mexico related to disturbance by agriculture and urban zones).



Map 3. Area of highest probability of presence of *C. moreletii* in Mexico (GARP area). Raw length of rivers and other perennial water bodies present within the area amount to almost 50,000 km (only the simple length of rivers was considered, leaving out the approximately equal length of the opposite banks; see below for explanations on further precautionary figure cuts).



Map 4. Yellow areas depict surfaces modified by agricultural and livestock raising activities, within the GARP area calculated for *C. moreletii* in Mexico. Slightly more than half (51%) has remained with suitable habitat for the species. Analogously, applying an additional cut of 49% to the previously obtained potential habitat length figure (*i.e.* perennial bodies of water), slightly more than 25,000 km of habitat length were retained; see details in text).

V.2.2. An estimate of the wild population of *C. moreletii*

Values of the index of crocodile abundance in ind/km, for 62 out of 63 localities (having excluded an extreme case with 38 ind/km of a lake in southeastern Mexico) as reported by COPAN, averaged 5.76 ind/km. Even though the distribution of data does not fit the normal paradigm, an attempt to calculate standard deviation sketched a confidence interval of 0.31 – 10.16 ind/km at the national scale. At least in principle, this variation might reflect differences in crocodile abundance among the array of sampling sites, each of them with particular circumstances.

Considering average index values known for other common crocodile species (see next paragraphs), an initial, tentative assessment of the potential population of *C. moreletii* in Mexico using an average as high as 5.76 ind/km, could be expected to produce some overestimation (despite the three rigorous cuts previously applied to the estimated length of potential habitat). On the other hand, although the confidence interval was always kept in mind, estimating a potential population for Mexico with its lower limit would certainly underestimate any actual figure.

Thus, since the statistical Mode reflects frequency trends better than the arithmetic average, with the aim of producing a more realistic –yet precautionary– figure, the Mode of the sample of 62 localities was calculated as a guideline; this resulted in a value of 3 ind/km. If an index of abundance of *C. moreletii* for Mexico is computed with the data reported by COPAN, the result is 917 individuals / 290 km = 3.16 ind/km. This value is very close to the statistical Mode, and was chosen for further calculations.

It is worth noting that, for many other crocodile species, values of abundance indices obtained with field methods comparable to those used for *C. moreletii* in Mexico, are not far from the figure we found: According to Ross (1998), *C. porosus* and *C. palustris* are among the crocodile species evaluated as in lower priority for conservation on a global scale. For *C. porosus*, with comparable methods, indices between 1 and 3 ind/km have been reported for Malaysia. For *C. palustris*, an index of 2.8 ind/km was informed for the State of Gujarat, India (Vyas and Vyas, 2002). Other species have been reported with indices as follows: 2 ind/km (*C. acutus* in Trujillo, Honduras; Cerrato, 2002); 2 - 2.1 ind/km (*C. novaeguineae* in Irian Jaya, Indonesia; Kurniati and Manolis, 2003); 0.3 – 4.7 ind/km (*A. mississippiensis* in the Everglades, Florida; Mazzotti *et al*. (2003).

Without any intention of making a strict, direct comparison, one cannot ignore the fact that the magnitude of the pondered general index of abundance of *C. moreletii* found in Mexico, based on data from 62 localities, is close to those reported from Belize (2.63), and from Guatemala (an average of 2.078). These not only compare favorably with indices known for lower priority species (Ross, 1998), such as *C. porosus* and *C. novaeguineae*, but also in some cases are slightly higher.

In summary the pondered, general abundance index found for *C. moreletii* in Mexico, reinforces the precautionary perspective considered necessary for this initial, global population estimate of the species.

Considering all these elements, the calculation of the **potential number of individuals (of all ages) in the wild population of *C. moreletii* in Mexico** yielded: 3.16 ind/km X 25,227 km = **79,718 individuals.** Due to the three precautionary potential habitat cuts, and one additional cut made on the index, dragging it below the average, this figure is most probably an underestimation of the real number, but at least gives a departing point for further refinement, without being too optimistic.

Furthermore, an estimate of the **potential number of adult *C. moreletii* in the wild in Mexico** was produced. This was done analogously projecting the percentage of adults observed in the sample provided by the COPAN Project (for 63 localities, 19% were Class IV size (>1500 mm, *i. e.* reproductive adults) to the gross population estimate. This gave 79,718 ind. X 0.19 = **15,146 estimated free-living adult individuals in Mexico**.

These data indicate that the potential population estimated for Mexico, with data from representative portions of all the distributional range of the species in the country is considerable. Keeping in mind the author's emphasis (Sánchez, in press $_{(b)}$) about the indicative nature of the result he obtained, it is very encouraging since it rationally substantiates preceding conjectures (such as: in excess of 10,000 wild ranging adults; IUCN Red List online, 2005). Available evidence does not give elements for supposing current endangerment of the species in Mexico.

A global estimation of the potential population of C. moreletii needs to include data from Guatemala and Belize. For Guatemala, the researcher considered the report by Castañeda Moya (1998) and that by Lara (1990). Information for Belize was that of Platt (1998) and Belize Zoo (2005).

Data for Guatemala were treated with a procedure as similar as possible to that used for Mexico. Castañeda Moya (1998) informed that the Peten is the general area of presence of *C. moreletii* in Guatemala, and that there are a total of 13,389 km of river banks there, *ca.* 50% are altered (this leaves a figure of 6,694.5 km of potentially suitable habitat). On its turn, Lara (1990) mentioned several indices of relative abundance for the Peten; this author's report allows for the calculation of an average of five indices resulting in 2.078 $\pm$ 1.40 ind/km.

Thus, lacking enough data for calculating the statistical mode, the average was used. This yielded 2.078 ind/km X 6,694.5 km = **13,911 individuals of all ages, estimated potential free-living population in Guatemala**.

So, assuming that in Guatemala, similarly to Mexico, about 19% of that number is represented by adults, an estimate of the **potential adult population in the wild in Guatemala** would be 13,911 X 0.19 = **2,643 individuals.** Currently, we have been informed that more detailed studies are on their way, and that priority areas for the conservation of *C. moreletii* in northwestern Peten (where populations seem to be in best condition; Castañeda Moya, 1998; and pers. comm., 2005) have been suggested.

For Belize, an average index of abundance, provided by Platt (1998), was of 2.63 ind/km. Lacking specific estimates of potential habitat length, some assumptions were made, as follows: a) Belize has an approximate area half of that of the Peten, b) Belize has a density of rivers and freshwater lakes similar to that of the Peten, and c) much as in the Peten and Mexico, *ca.* 50% of habitat length might remain suitable for *C. moreletii* in Belize. With these provisions and data, a potential habitat length of 3,347.25 km was calculated for Belize. With the index value given by Platt (1998), the estimate of **potential free-ranging population (all ages) for Belize** was of 2.63 ind/km X 3,347 km = **8,803 individuals.**

Applying the generalized restriction of only *ca.* 19% adults are present in a given population within a sizable area, the estimate of **potential adult population of *C. moreletii* in the wild in Belize** is 8,803 X 0.19 = **1,673 individuals**. In addition to the figures calculated by Sánchez (in press $_{(b)}$), the Belize Zoo has expressed that the population of this species has recovered from a precarious state in 1981, thanks to the enactment and steady enforcement of the Wildlife Protection Act (Belize Zoo online, 2005).

With component figures for Mexico, Guatemala and Belize, arithmetically, the **estimate of the global population of *C. moreletii* (all ages)** would be of **79,718 + 13,911 + 8,803 = 102,432 individuals**. On its turn, with figures currently available, the **estimated potential, global adult population of *C. moreletii*** resulted of 15,146 **+ 2,643 + 1,673 = 19,462 individuals**.

In conclusion, rounding figures obtained with the best information at hand, a current, working estimate of the **potential global population of free-ranging *Crocodylus moreletii* (all ages), is of slightly more than 100,000 individuals**.

In the same terms, a current, working estimate of the **potential global adult population of *Crocodylus moreletii* in the wild, is of nearly 20,000 individuals**.

Following the recommendations of the researcher in charge of the estimations (Sánchez, en prensa(a)), the final figures just explained should be considered as a reasonably acceptable departing point for an initial population assessment of C. moreletii, but not as a strict, unmovable reference. Thus, these results must be subject to future updating and correction, considering new field and geographic data as they appear. Another pertinent recommendation of the author is that special emphasis should be given to the improvement of monitoring protocols, seeking enhanced systematicity and homogeneous application throughout the species' range.

V.3. An estimate of probability of extinction

The same researcher who produced the population estimates described above (Sánchez in press $_{(a)}$ and $_{(b)}$) also developed a first Population Viability Analysis (PVA). The Vortex program was used for that purpose (Version 9.42; Lacy *et al*., 2003). A single, global population was modeled, of only 30,000 initial individuals since this is the limit of Vortex (an astringent scenario, given the fact that the actual estimate is more than three times larger). Population extinction was restrictively defined as 500 animals remaining but incapable of maintaining a viable population (a much more strict condition as compared to, for example, only 100 individuals remaining or total depletion of individuals). Vortex was fed with current biological and ecological information for *C. moreletii*, including size and sex proportions, reproduction and other. The scenario was set for a lapse of 500 years, with catastrophe factors related to habitat alteration and decrease of prey availability, implying a progressive diminution of carrying capacity at 0.15% per year (*i.e.* a global decrease of 75% of the carrying capacity after 500 years).

As can be seen, the model included high stress (hardly probable in the real world, but allowing for worst-scenario predictions). For statistical significance, 500 runs of the population trajectory were performed (500 years of simulation, each).

The results of the dynamic modeling described above indicate that probability of extinction, even as strict as was defined and for a global population just 1/3 of the actual estimate (which is the top initial population number that the software accepts to perform the modeling), and after 500 years, would be very low (0.1380 ± 0.0154, standard error). Seen the opposite way, probability of survival of a population of only 30,000 initial individuals, even under such high stress, would be considerably high 0.8620 (± 0.0154, standard error).

Eighty six percent probability of survival under such simulated stress is an encouraging indication, especially because the simulation was run for a hypothetical population of *C. moreletii* one third smaller than the current estimate. See Figure 3, Results of modeling probability of extinction for *C. moreletii*.

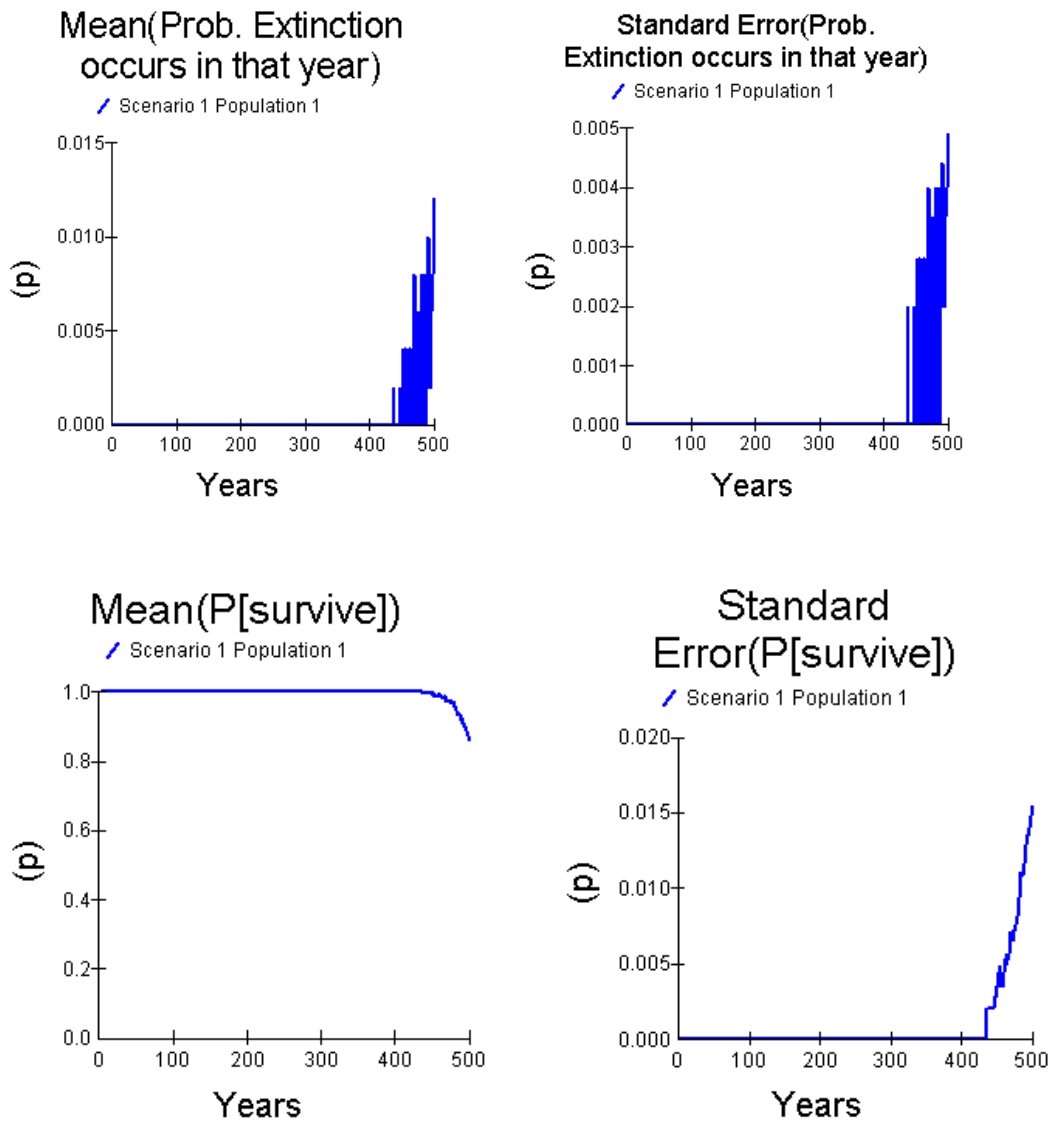


Figure 3. Results of population trajectories generated with Vortex 9.42. The model simulated a hypothetical population of *C. moreletii* through 500 years, departing from an initial number as small as 1/3 of the actual global estimation of about 100,000 individuals of all ages. In other words, simulated as if only *ca*. 6,500 adults existed in the wild.

Even in a scenario as unfavorable as the one designed for the model (much more restrictive than currently predictable in the real world), statistically, the surviving population at the end of the 500-year lapse would be *ca*. 1/6 of the initial 30,000 individuals (*i.e.* (4,626.37 individuals ± 124.77 standard error). Results of the PVA lead to conclude that a species with attributes such as those included in the model (*i.e.* known attributes of *C.*

moreletii) is very resilient; this is to say it has high elasticity, which confers it both resistance and capacity for vigorous population recovery.

In the model and after 500 years, statistically, genetic diversity remained very high along the 500-year period. Heterozygosity (=presence of different genetic alleles at the same chromosomal site) resulted high at the end of the period (0.9865 ± 0.0003 standard error); in fact, it almost remained at the maximum of 1.0. This trend of keeping a high genetic diversity after a long period is one of the factors that underlie adaptability when facing environmental change. In terms of *C. moreletii*, this would imply that, assuming this is a genetically robust species and one with considerable tolerance to habitat change, and a generalist feeder, all these factors would explain the great elasticity that has allowed it for the population comeback we are seeing. See Figure 4 for the trend seen in the genetic modeling.

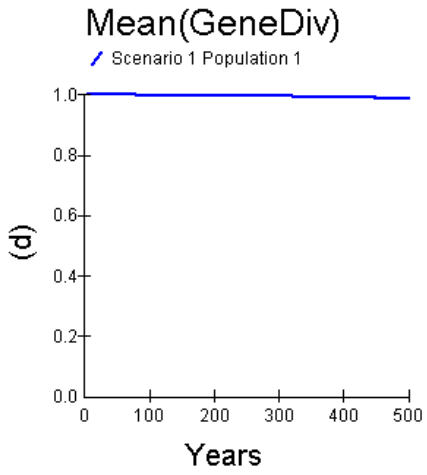


Figure 4. Genetic diversity in the population of *C. moreletii* modeled as described above. The estimated loss of genetic diversity resulted clearly negligible.

The results obtained with this model for *C. moreletii* (Sánchez, in press $_{(b)}$), are consistent with the current situation of the species: After 34 years of effective ban of the commercial capture in the wild in Mexico, the population of this species in the country has shown, at the beginning of the XXI Century, indices of relative abundance (ind/km) comparable to those known for other crocodile species globally considered as common.

Considering that the current global population estimate for *C. moreletii* is more than threefold of defined as the initial population for the PVA model, if the model could have been run with such a number (*ca*. 100,000 individuals), the results would have been still more encouraging.

In fact, although one must actually admit that there are stress factors for *C. moreletii* in the wild, these are by far less severe than those imposed in the past by commercial capture. Furthermore, stress factors for *C. moreletii* in the real world are much less drastic than those included in the model, which may allow for a promising future for the species if conditions remain stable, and especially if these improve as it is desirable and possible.

These estimates, of population size and probability of extinction, should be periodically updated and corrected as needed, so as to maintain a current perspective consistent with any changes that might occur in the future. This calls also for progressive refinement of the models.

Departing from information now available about the global status of *C. moreletii* in the wild, today the scene appears as one of notorious recovery of the species. On the basis of the analyses recently developed by Ó. Sánchez it is suggested that consolidation of that recovery could be achieved by incorporating through several possible actions into national policies:

a) Determination of zones within the GARP area requiring habitat restoration, especially where crocodiles have been reported, and continued attention for the increase of areas available to the species;

b) Increasing representative quality of the field monitoring of the species for its whole distributional range. Once an agreeable design has been reached, monitoring can be done every five or six years to allow for population changes to be detected, if any. Monitoring requires refinement of methods and uniformity in their application, throughout the range of the species and in the three countries;

c) Refinement of the promising design of a *C. moreletii* database, departing from that adopted by the COPAN Project and seeking its solid consistency with the design of monitoring activities. Working towards consensus among Mexico, Guatemala and Belize, for the uniform application of methods, databases and analyses, is advisable;

d) Increasing outreach activities for the general public, concerning the importance of the species, as well as consolidating contributions from more partners and stakeholders, to ensure its permanence by reducing known stress factors; and

e) Developing a solid previous evaluation of cost-benefit relations, ecological, social and economic, of any eventual future projects involving wild populations of *C. moreletii* (be them ranching, ecotourism, or other).

Concluding, it can be said that available information for Mexico (Domínguez – Laso *et al*., 2004), Guatemala (Castañeda Moya, 1998; Lara, 1990), and Belize (Platt, 1998) analyzed with static and dynamic models (Sánchez, in press $_{(a)}$ and $_{(b)}$), allow for the consideration that no reasons currently exist for regarding *C. moreletii* as an endangered or threatened species.

V.4. Data on international trade with *C. moreletii*

From data on the international trade in crocodile skins for 1996 – 2004, available from UNEP – WCMC Trade Database (2005), referable to whole skins (=individuals) and excepting cuts and secondary materials, it can be seen that:

The world market of crocodile skins, equable to individuals, shows an increment from 1997 to 2000, and later an important downfall in 2002, to a level close to that of 1998 (*ca.* 1,100,000 individuals). Reasons for this trend are unclear, but far from revealing an expanding market, this behavior suggests one with signs of depression. See Figure 5 for details.

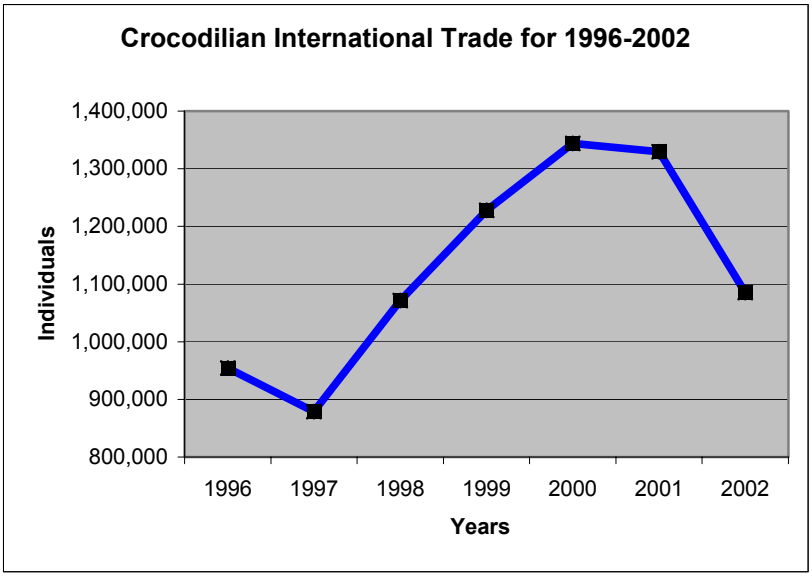


Figure 5. The world market related to crocodiles seems to have been through a steady increase in the late XX Century, but only to show signs of depression in the early XXI Century (source of data UNEP – WCMC, 2005).

International trade with *C. moreletii* is very low, which seemingly implies that no severe danger to the continuity of the species can derive from it. During the first half of the XX Century hundreds of thousands of skins a year were marketed; the current level is of about 6,820 individuals in a 6-year period (*ca.* 1,100 ind/year). This means two orders of magnitude below the level of trade that threatened the species until 1970; plus, only captive-reared individuals are now legally allowed for commercial purposes in Mexico, Guatemala and Belize.

As can be seen if Figure 6, *C. moreletii* represents only a small fraction of the trade in crocodilians at a global scale, qualifying only to the lowest level, really far away from the market leaders: *Caiman crocodilus fuscus, Alligator mississippiensis* and *Crocodylus niloticus*.

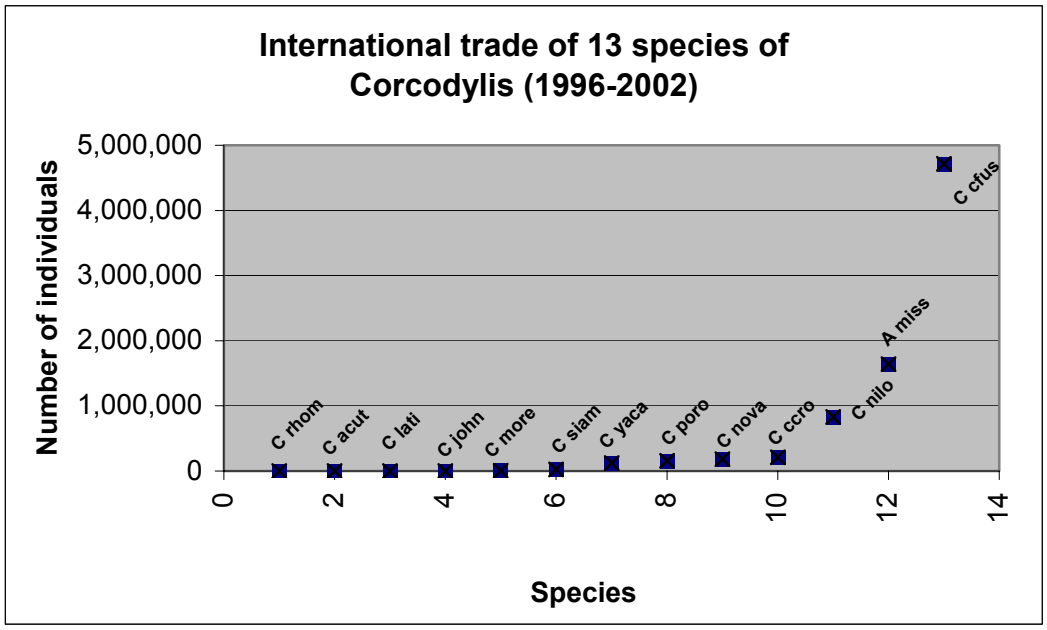


Figure 6. Current trade with *C. moreletii* would not be anticipated to represent a threat for the species, since the highest volumes of the world market correspond to taxa such as *Caiman crocodilus fuscus*, *Alligator mississippiensis* and *Crocodylus niloticus* (UNEP-WCMC, 2005).

Particularly for *C. moreletii*, skin trade originating in Mexico shows a trend that apparently reflects that of the global international market for crocodilians. This is, it grew at the end of the XX Century, and steadily decreased from 2001 to 2003 (see Figure 7).

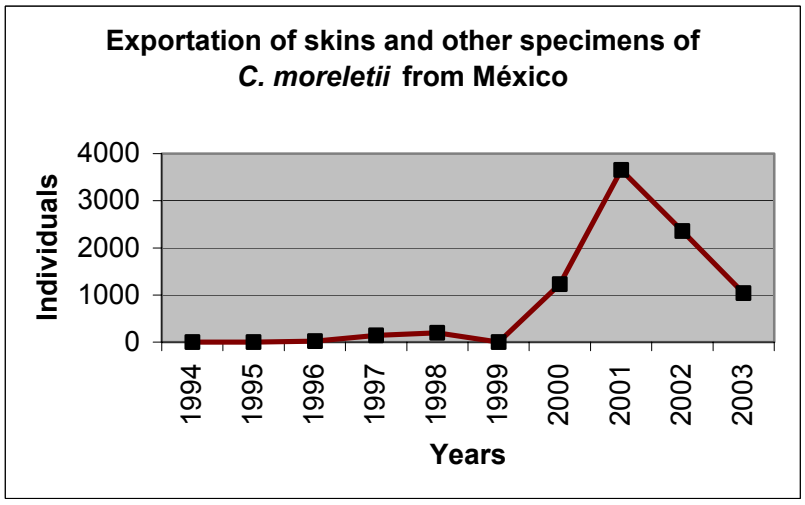


Figure 7. Export transactions of *C. moreletii* from Mexico reveal a low volume as well as a recent decreasing trend, seemingly reflecting the behavior seen in the international market. From the aforementioned information, it can be concluded that current market trends would not seem to pose a threat, or an obstacle, for the recent recovery of the species in the wild. Besides, the capacity for captive production of *C. moreletii* in Mexico clearly surpasses the total demand known to date.

VI. *Crocodylus moreletii* and the criteria of the U.S. ESA

This analysis was developed with the best information at hand on the species *C. moreletii*, and taking into account the criteria of the U.S. ESA for determination of the status of a given species as Endangered or Threatened.

This exercise was developed during a recent workshop with participation of many *C. moreletii* experts. It has been reported in the IUCN-CSG Newsletter (October-December, 2004), and was convened by Conabio at Mexico City, December 1st and 2nd, 2004; see Annex 4, for a list of participants). Input for that Workshop included field data collected by the COPAN Project during 2002 – 2004, some data known for Guatemala and Belize, and decisions involved the need for its objective, scientific analysis, results of which were recently produced, as reported above.

Criterion A. Present or threatened destruction, modification, or curtailment of its habitat or range.

The distribution area of *C. moreletii* in Mexico was calculated by means of the GARP algorithm, on the basis of information linked to available field records of presence. It resulted in 396,455 km^2 (see Map 3). When the Guatemalan Peten and Belize are added, the total extent of occurrence of *C. moreletii* adds up to more than 450,000 km^2 (see Map. 1).

In Mexico, during the Spanish conquest in the XVI Century, the Gulf versant was among the first territories colonized. This brought about alteration of numerous areas in the states of Veracruz, Tamaulipas, and part of Tabasco, where massive dismounting of forests occurred for introduction of cattle-raising practices and more agriculture. Now, 480 years have passed since those events happened, and 51% of the area of extent of occurrence of *C. moreletii* (202,169 km^2) remains with environmental conditions suitable for the species. Even more, within the 49% of the area subject to historical alteration, many places still bear populations of *C. moreletii*, as shown by data obtained by the COPAN Project (see Map 4).

Today, Mexican law has robust restrictions for changes in land use (e.g. the Ley General del Equilibrio Ecológico y la Protección al Ambiente; LGEEPA). This allows for the prediction that no significant reductions of the remaining 51% of good-quality habitat in the area of extent of occurrence of *C. moreletii* are expected to occur and, of course, never of the magnitudes seen in the XVI to early XX Centuries.

It can be concluded that the alteration of an important portion of the extent of occurrence of *C. moreletii* is not new, but as old as the Spanish conquest, and that it is under control since the passing of the LGEEPA (1988). Even in that prolonged historic context of alteration, wild populations of the species remained abundant (so much that high-scale commercial exploitation was profitable for unscrupulous persons until the first half of the XX Century). More recent environmental alteration has probably produced some additional deterioration of populations of *C. moreletii*, but not comparable to that of the past. On the other hand, even in areas where changes to the original environment are not reversible, evidence points to a certain degree of tolerance on the part of *C. moreletii*, especially when the causes are agriculture, or low-technology livestock production.

In the last 60 years, industrial development in Mexico has required construction of infrastructure in some portions of the range of *C. moreletii* (*e.g.* oil wells in southern Veracruz and Tabasco, and thermoelectrical plants in northern Veracruz). Fortunately, starting in 1988 with the enactment of the LGEEPA, every new project has to fulfill strict protocols for the assessment of environmental impacts, before it can be approved.

Development of conventional tourism facilities is also subject to that law and, fortunately, there is no evidence indicating that that activity may have caused sensible alterations of areas inhabited by *C. moreletii*; furthermore, the species has demonstrated high resilience and has proven to be able to persist in areas with moderate alteration.

In summary, today, at least 202,169 km^2 in Mexico keep offering suitable habitat for *C. moreletii*; evaluated as apt or excellent by the COPAN personnel (Mexico, 2002 –2004; 42 localities throughout the range of the species in the country). We emphasize that several types of environmental modifications are not automatic synonyms of local extirpation of *C. moreletii*.

It is true that not all altered areas recover in a spontaneous way, but some do. Besides, in many cases, conditioning restrictions for the development of infrastructure and economic activity have already had positive effects in Mexico, and responsible companies are actually taking steps –since at least 10 years– to achieve the restoration and compensation goals they have been legally imposed.

Citizens are also effectively improving their commitment, towards timely detection and denunciation of illegal attempts of environmental modification. This means that environmental authorities have now a co-adjuvant for the dissuasion of illicit activities, contrary to ecological ethics and to the law. Compliance of environmental protection starts with prevention, and Mexico has been actively focusing on this during more than 15 years now.

In northern Guatemala, the Peten region is the most important stronghold for *C. moreletii*. According to Castañeda Moya (1998), before 1960 the Peten was sparsely populated (15,000 to 21,000 human inhabitants were estimated for that time). Starting in 1961, an official program fostered colonization, and this caused environmental alteration, as well as an increase in human conflicts with crocodiles. That author estimated that slightly above 50% of potential habitat for *C. moreletii* is now altered. Currently, some studies on the status of habitat and populations of *C. moreletii* are in course, and potential threats for habitat persistence are under assessment.

In Belize, virtually all of the country contained suitable habitat for *C. moreletii*. The style of economic development of that country, to date, has not required massive alteration of the natural environment; thus, in general, it can be said that no extensive and drastic alteration of the habitat of *C. moreletii* has occurred in Belize. Recently, the perspective for construction of a large hydro electrical dam, and its possible negative effects on biodiversity is under discussion in that country. Rather paradoxically, although projects of that kind imply undoubted threats for many components of biodiversity, for *C. moreletii* they could even mean a partially favorable factor, in terms of future habitat available in lowland areas.

In the light of the facts explained above, it would not be expected that present or future destruction, modification, or curtailment of the habitat or range of *C. moreletii* may present an important threat for the survival of the species, nor be of a magnitude comparable to that occurred since the Spanish conquest and until the first half of the XX Century.

Criterion B. Over-utilization for commercial, recreational, scientific, or educational purposes

Commercial use.- No doubt, commercial over-exploitation of *C. moreletii* for more than 100 years (from the middle XIX to middle XX Centuries) was the main cause of its drastic population decline. As a factor of degradation it was far more severe than any reduction of habitat, because the capture of tens of thousands of adult animals a year, for skins, reduced the reproductive capacity of wild populations in a significant way.

Fortunately, the positive effects of the total and permanent ban of commercial capture of crocodilians in the wild, imposed in Mexico in 1970 and enforced during 34 years now, are quite evident. In addition, operation of captive-breeding facilities for *C. moreletii* during almost 30 years has successfully reverted the former trend towards deterioration of the species.

The notorious biological resilience of the species has allowed for its recovery from the severe reduction it suffered in the past two centuries. As demonstrated by survey results of 2002 – 2004, the species remains present along its whole natural area of distribution and with reasonably high levels of abundance in virtually all of its distributional area in Mexico. This is valid even for those areas of the country historically known as of past overexploitation (such as Tabasco and Veracruz).

Currently, all commercial exploitation of *C. moreletii* in Mexico occurs, in a mandatory way, with animals actually born and raised in captivity (full reproductive cycle implied, and beyond the second generation) within administrative units designed as Unidades de Manejo y Administración de Vida Silvestre (UMAs). In addition to the obvious benefits this means for wild populations, diverting commercial pressure away from them, governmental control on commercial activity with this species gets tighter.

As for Guatemala, Castañeda Moya (1998) stated that for that year some illegal capture of *C. moreletii* subsisted in the Peten. However, he admitted that the amount of such activity had decreased, as compared to the high level seen 25 years before. During certain months, fishermen increase their efforts in the Peten in response to demand for fish in local markets, and some incidental capture of *C. moreletii* in nets has been reported. In any case, this is not a large-scale phenomenon in terms of the low actual number of crocodiles accidentally caught. In general terms, the trend in Guatemala appears as one of progressive decrement of illegal capture.

In Belize, crocodiles are also given official protection, and this enhances positive expectations for *C. moreletii* against commercial capture and occasional poaching, depending on regular surveillance of areas with known occurrence of the species. The relatively small geographical extension of Belize makes effective surveillance a feasible enterprise. In any case, no commercial-scale capture is known to occur in that country.

Recreational use.- Few initiatives offering adventure tourism related to the Morelet's crocodile are known throughout the extent of occurrence of the species. In Mexico it may be occurring in an estimated of less than 0.01% of its range. No figures are known for Guatemala and Belize, but at least there are indications of interest in developing such endeavors. Be it as it may, far from being a source of concern, if responsibly managed in all three countries, these activities might represent an additional impulse for crocodile conservation and for economic development of rural communities.

In order to ensure success and sustainability of recreational uses of *C. moreletii* by means of these non-consumptive activities, it has been recommended (Ó. Sánchez, pers. comm., 2005) that no massive and frequent tourism be allowed, but instead low-profile (in number and frequency of visitors), geographically well distributed and diversified options, be maintained. This will help protect crocodile populations, and maintain a high-quality adventure, photographic and informative experience, named scientific tourism by some experts (Domínguez –Laso, 2002).

Scientific use.- In Mexico, biological sample collection from wild species intended for scientific study is regulated by the Norma Oficial Mexicana NOM-126-SEMARNAT-2000. Mexican research institutions are required to comply with its terms and, when export of samples of any crocodile species is needed for study, promoters are required to behold the NOM-126 permit as well as an official CITES certificate, with authorized tags for cases thus mandated by law and emitted by designated authorities. Foreign researchers wishing to export biological samples of crocodiles for scientific research are equally required to hold valid permits as explained above. According to available data, amounts of those export movements are relatively small, as can be seen in sources such as UNEP – WCMC, and in data available from Mexican authorities.

Scientific research on *C. moreletii* in Guatemala can be described as in a stage of consolidation, and most of it occurs within that country. No indication of over-utilization with scientific purposes is known for Guatemala.

On its turn, Belize has been an important center of operation for several research projects, (mainly ecological and on genetics) focusing on *C. moreletii*. This has involved field and laboratory research. For the export of biological samples of crocodiles for scientific study, Belize has strict official provisions and protocols, as can be seen in several research articles published in scientific journals about this crocodile species. Besides that, the number of research projects has never been so high so as to imply any significant negative impact on wild populations of *C. moreletii* in that country.

It has to be noted that in Mexico, as in Guatemala and Belize, most scientific research on *C. moreletii* has focused on field surveys for the presence of this species, its relative abundance and habitat quality, none of which require removal of individuals. Research protocols followed so far, have been those accepted worldwide and do not involve significant alteration of their habitats and behavior. On the contrary, the impact of research activities related on this species have contributed and supported conservation measures.

All of the above-explained facts point out that, currently, no overexploitation of *C. moreletii* seems to occur either for commercial, recreational or scientific use.

Criterion C. Disease and predation

Crocodilian populations are able to regulate their health state by means of physiological links with the environment. In acceptable conditions of space, food availability, temperature, and direct sun exposure, their immunological system responds quickly and effectively against disease. The recently documented presence of antibiotic properties in several body fluids –notoriously the blood– reinforces their self-defense abilities against pathogens, especially bacteria (but not to the exclusion of others).

As it occurs for all crocodilian species in the world, chances are that other etiological agents of disease (such as viruses or protozoans) may debilitate and sicken a few individuals. In wild populations, such cases might carry possibilities for contagious effects or dispersion of a given disease; however, these are highly reduced by processes of natural regulation such as predation of weakened individuals. All these mechanisms act as limiting factors for the propagation of most illnesses (Gallegos and Sigler, 2003).

Presently, there is no evidence of any pathogen significantly affecting wild populations of *C. moreletii.* There are some findings derived from the isolation of potentially infective bacteria from *C. moreletii*: microorganisms found include enterobacteria such as *Klebsiella*, *Citrobacter*, *Salmonella*, *Proteus*, and others from the Staphylococcus group that, although apparently innocuous in healthy crocodiles, might turn opportunistically infective if a weakening of the immunological system of a crocodile occurs. However, to date, no losses of crocodiles in Mexico are attributable to these microorganisms (Lucio *et al*., 2002).

Natural predation on *C. moreletii* occurs mainly, as for many other crocodilian species, since the egg stage. Later on, juveniles remain highly vulnerable to several natural predators until (for *C. moreletii*) they are over 900 mm in total length. Up from that length few carnivores may prey on them and, in the adult phase of life, only large predators such as the jaguar may remain relevant for this crocodile (Álvarez del Toro and Sigler, 2001).

During juvenile stages, individuals of *C. moreletii* may be preyed upon by larger conspecifics; however, this tends to act as an early factor promoting population regulation and adult spacing. Agonistic interactions among adults seem to be reduced by this mechanism, especially in populations with too many adults. In populations with a steady state of age distribution, cannibalism usually remains at a minimum. According to available data, size class proportions in a combined sample of *C. moreletii* from Mexico do not provide evidence that cannibalism could be of concern.

On the other hand, no evidence exists that any exotic and/or invasive species, deliberately or accidentally introduced or that autonomously expanded its natural distribution range into the natural habitat of *C. moreletii*, could be a foreseeable threat for this crocodile species, either as a predator or as a significant competitor. Predation of nests and juvenile crocodiles thus far documented is related to natural predators. This is valid for all of the range of *C. moreletii* in Mexico, and probably also for Belize and Guatemala, and must be considered as part of naturally occurring ecological processes.

In summary, no disease or predation factors of concern are presently known for natural populations of *C. moreletii*, in all of its geographical range.

Criterion D. <u>The inadequacy of existing regulatory mechanisms</u>

Since 1970, and stimulated by the concern about the drastic diminution of wild populations of *C. moreletii* in the XX Century, Mexico decreed a total ban, of national coverage, for the commercial capture of all crocodile species. This ban had to be backed by effective presence and scrutiny of authorities in those areas previously known as of concentration of catch and, also, by surveillance in known centers for skin treatment and product confection and direct trade. Border port surveillance and law enforcement in general had to be reinforced to ensure contundency and effectiveness of the ban.

As is understandable, the enormous extension of Mexico where *C. moreletii* exists meant a formidable challenge for the conservation of this taxon (especially for law enforcement as explained above). Despite this, now, results speak for themselves demonstrating an ample recovery, as indicated by field data gathered by the COPAN Project between 2002 and 2004 and the results of their scientific analysis.

Te coverage of official operations in law enforcement was not the only area treated. Mexico has promoted and developed, since at least the last 10 years, a policy of continuing creation of new protected natural areas and of maintenance of those already existing. Today, the National Protected Areas System (SINANP) includes at least 12 areas that give additional protection to *C. moreletii* in an estimated 13% of its geographical range.

In spite of the recovery of the species being a reality, instead of assuming this comeback as a consummated fact, Mexico continues invigorating efforts towards law enforcement and towards the continuing improvement of existing legislation and administration. This aims to the widening of current protection of all wildlife species and their habitats, including *C. moreletii*.

Since more than two decades now, Mexico has developed an important strategic complement with a preventive perspective: in those 20 years, the establishment and operation of full reproductive cycle crocodile farms –with proven beyond-second generation viability– has been actively fostered by the federal government. Currently, the ecological legal dispositions of Mexico include the Wildlife Management and Conservation Units System (SUMA). This national system consists of officially registered and supervised units (UMAs) where wildlife species are managed for reproduction and conservation. In the case of the Morelet's crocodile, these full-cycle farms have interacted with scientific research institutions, educational institutions with an interest on the conservation of the species, and have been supported, and in cases owned and/or managed by private investors wishing to support conservation through sustainable economic activity with the species. This has facilitated technical improvement of entirely captive reproduction with an eye on cost-benefit, which has advantages both for economically viable maintenance of a stock for eventual reintroduction and for legal commercial operations. Mexican law dealing with ecological and commercial aspects has direct applicability to such full-cycle crocodile farms.

Some of these farms have already attained capacity for medium-scale commercial operation, and a high organization level for keeping control of their procedures. This has earned them official certification by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), of which Mexico is Part since 1991. The CITES

still keeps *C. moreletii* within Appendix I (its original designation since 1975). Appendix I sets the strict conditions under which specimens of species listed may be traded, but only if they are proven to come from entirely captive reproduction in certified farms and in accordance to Resolution Conf. 10.16, regarding regulation and trade of specimens of animal species bred in captivity. That certification implies the formal commitment of those farms, for not supplementing their stock or otherwise exerting any trade with wild-caught specimens. Mexican authorities are especially vigilant of the fulfillment of the obligations of any CITES certified wildlife reproduction facilities.

All facts mentioned above occur in an official framework that integrates conservation with an aperture towards effectively sustainable use of wildlife species. This framework has been progressively covering more aspects in environmental matters (Brañes, 2002; INE, 1999; INE, 2000; Profepa, 2003; DGVS, 2002). In fact, since 2000, Mexico launched the Programa de Conservación de Vida Silvestre y Diversificación Productiva en el Sector Rural. This Program defines the conceptual, strategic, legal and administrative framework to which any initiative for the use and conservation of wild species must strictly adhere. A special feature of this Program is that it attempts to grant clarity and certainty in the solution of human needs in rural areas, procuring conservation based on present-day paradigms about the sustainable use of natural resources.

Furthermore, for the special case of crocodiles and since September 1999, Mexico formed a technical advisory body, the “Subcomité Técnico Consultivo para la Conservación, Manejo y Aprovechamiento Sustentable de los Crocodylia en Mexico (COMACROM)”. This is a multi-way consultant organ for Mexican wildlife authorities, especially focusing on the orientation of conservation programs, and notoriously including *C. moreletii*. As explained at the beginning of this document, COMACROM includes scientists, technicians, non-governmental organizations, producers, all authorities involved, and other stakeholders. These experts periodically meet and analyze available information on Mexican crocodilians. Opinions emitted by COMACROM provide important guidelines that feed an adaptive management mechanism, supporting actions intended to consolidate the current, visible recovery of wild populations of *C. moreletii*. COMACROM also participates in meetings of the Crocodile Specialist Group (CSG-SSC-IUCN), and sends contributions for the Crocodile Specialist Group Newsletter, besides having official representatives at the CSG.

The conservation activities just described delineate the current degree of integration of the legal and administrative frameworks for conservation in Mexico. In recent years, this system has been reinforced with the passing of Official Norms dealing with finer details of wildlife conservation, such as the determination of the status of risk of species in the Mexican territory. The Norma Oficial NOM-059-SEMARNAT-2001 had its immediate ancestor in the Norma Oficial NOM-059-ECOL-1994, which became updated with the addition of a scientifically based and officially approved method for the determination of the status of risk of wild species (MER), explained in detail by Tambutti *et al*. (2001). Currently, the NOM-059-SEMARNAT-2001 does not consider *C. moreletii* as imperiled or under threat, since all available evidence was considered as enough to demonstrate evident recovery of wild populations. However, with the precautionary stance characteristic of Mexican policy for the conservation of wildlife, invigorated during the last two decades, the NOM deliberately takes measurements to ensure stability of this present-day recovery of *C. moreletii*, by taking the species under its custody by putting it in the category of Subject to

Special Protection or *Pr* (i.e. taxa not currently under risk, but of high interest for the Mexican people so that they deserve to remain under the protection of the State to ensure their continuity and abundance). This specific measure allows the Mexican federal government an additional option to reinforce, maintain and innovate policies aiming to keep the steady pace of recovery and permanent protection for particular species such as *C. moreletii*.

As explained, Mexico has adequate regulatory mechanisms both in the law and its enforcement, to ensure the permanence of *C. moreletii* as a wild species viable to the future. The sufficiency of these mechanisms has been proven by the evident recovery of the species itself. Annex 3 describes the legal and administrative framework for conservation in Mexico in greater detail.

In Guatemala and Belize, the respective environmental laws are in an active process of furthering their coverage and improving effectiveness. This constitutes a most welcome support for the Mexican efforts, since complementarity among national laws in the international scenario is one of the key factors for success in conservation.

Criterion E. <u>Other natural or manmade factors affecting its continued existence</u>

It is really hard to name natural factors that can compromise the survival of *C. moreletii*, since its mere existence, and that of several other crocodile species, attests the capabilities for endurance of crocodilians since the Triassic (200 million years before present). They have even survived global catastrophes, such as the one that caused the demise of dinosaurs (K-T event, 65 million years before present).

Even natural phenomena such as hurricanes, in the long run, may tend to favor *C. moreletii*, because flooding allow crocodiles to move among lakes and even among basins, with consequent benefits for genetic variability and viability of the species. Given the ample distribution of the species, and its presence in most of its geographic extension of occurrence, only very local cases of temporal disappearance of ponds or "aguadas" during the dry seasons may be expected to cause temporal alterations, probably in terms of an increase in population density at adjacent permanent water bodies. Otherwise, at the global scale, evidence does not indicate that natural factors can pose a hazard for the continuity of the species in the long term.

Factors related to human activities, and of potential risk for *C. moreletii*, would currently be those related –as already pointed out in this document– with the construction of oil infrastructure in swamp areas. In a secondary level, construction and operation of thermo electrical centrals may be cited. In a third place, the operation of chemical and transformation industries, if improper disposition of potentially toxic residual materials eventually occurs. On the positive side, as described in detail in the section on legal regulatory mechanisms, establishment and operation of these industries is now subject to strict compliance of the Ley General del Equilibrio Ecológico y la Protección al Ambiente (LGEEPA) and every norm linked to it. Supervision of these important aspects is responsibility of the Mexican law enforcement authority, Procuraduría Federal de Protección al Ambiente (PROFEPA), which pays close attention and maintains surveillance where it is most needed. Presently, there are instances of exemplary sanctions applied to infractors of environmental law, regardless of their private or official nature, and including

imprisonment, pecuniary and/or damage compensation or restoration, as merits deserve according to the law.

In other perspective, land distribution has already concluded, and no government programs fostering colonization of new areas do exist at present. This makes new human settlements a minor threat. Rather than being surprised by human settlement growth, it the evident growth of crocodile populations is a matter of recognition. This is demonstrated by the analyses presented in previous sections of this document, and by the apparently increasing rate of reports of the presence of crocodiles by people living in areas where those animals had not been seen for decades.

Among several instances known to the various Mexican specialists, a very recent one (February 2005) illustrates the kind of situations that occur. A *C. moreletii ca*. 2 m in length appeared in an artificial maintenance pond, opening into a nearby swamp, in an electrical central of the Comisión Federal de Electricidad (CFE) at Poza Rica, Veracruz; an unprecedented issue in the history of that facility. The CFE reported the finding to the Mexican authorities, which readily contacted specialists who advised CFE on the best way of action for resolving the potentially conflictive situation, namely the relocation of the animal.

Thus, although operation of infrastructure located in natural environments may have a potential for confrontation between humans and crocodiles, the new social attitude towards wild species promotes conflict solutions compatible with conservation.

Concluding, the continuing existence of *C. moreletii* does not appear compromised by additional, natural or manmade factors, as defined in the ESA.

VII. Conclusions about *C. moreletii* and the criteria of the ESA

A detailed revision of available evidence, mainly contained in the proposal for the modification of the status of *C. moreletii* in the U.S. ESA, in the six Annexes, in the scientific literature, and in technical reports of the archives of government agencies in Mexico, and their equivalents for Guatemala and Belize, allow for the following conclusions:

a) *Crocodylus moreletii* is widely distributed in the low sloped and coastal plain of the Gulf of Mexico, the Yucatan peninsula, Guatemala and Belize (e.g. only in Mexico, 202,169 km^2 are considered as suitable habitat for the species). Today, populations of this crocodile show evident signs of recovery. Considering development trends in Mexico, Guatemala and Belize, there are no elements to foresee any actual or potential destruction, modification or degradation of habitat of a severity and magnitude comparable to those occurred since the XVI to the middle XX Centuries.

b) In Mexico, Guatemala and Belize, commercial exploitation of wild populations of *C. moreletii* is forbidden. Complementary to this important restriction, at least in Mexico, there exists an abundant and robust captive stock of Morelet's crocodile (fully reproduced and raised in captivity), of potential value for eventual repopulation of areas as well as for commercial purposes.

c) There is no indication that tourism, or scientific activity, may signify negative influences or significant threats for wild populations of *C. moreletii*.

d) Up to now, and for the whole range of the species, there is no indication that disease may deserve consideration as a threat for the continuity and future viability of wild populations of *C. moreletii*. Similarly, apart from natural predation known for the species (and present along all of its evolutionary history) there are no indications that predatory species, native or exotic, may represent a stress factor for *C. moreletii*.

e) Present-day legal regulatory mechanisms and law enforcement in Mexico, directly and indirectly applicable to *C. moreletii*, have resulted adequate and sufficient as shown by the recovery of its wild populations now supported by initial systematized field data. Recovery seems robust, as is the legal framework supporting it. Equivalent legal systems in Guatemala and Belize lend further strength to the legal protection of the species in all of its natural range.

f) Even though the operation of industrial infrastructure located in natural landscapes of Mexico implies some interactions with crocodiles, negative outcomes of conflictive situations are seldom seen. Opposite to the attitude (or lack of) towards crocodiles during most of the XX Century, negative impacts of human conflict with crocodiles can be reduced thanks to an increasing citizen's good disposition for cooperation with environmental authorities. Most eventual human-crocodile conflicts are resolved by relocating animals.

The Mexican strategy for recovery of wild populations of *C. moreletii* has three essential components:

1) The complete prohibition of commercial capture in the wild, its supervision and strong law enforcement;

2) The designation and stewardship of an increasing number of protected natural areas (ANPs) and their integration in the National Protected Areas System (SINANP), in such a way that their permanence, stability and care can be guaranteed for the future; and

3) The encouragement for productive activities that give primary and secondary support to conservation, and to the effective sustainable use of the species, especially those implying continuous full-reproductive cycle captive reproduction.

As always, Mexico keeps up the spirit of cooperation with other countries, particularly with the United States of America. The co-adjuvant role of the prohibition of import of specimens, products and by-products of *C. moreletii* to U.S. territory was instrumental for the current recovery of the species, in times of trouble for wild populations, threatened by commercial capture until 1970.

Very fortunately, the high intrinsic capacity for recovery now evident for the species, coupled with Mexico's efforts for its conservation, have yielded successful results. Removal

of commercial capture in the wild as a pressing factor on the species, the designation of more protected natural areas, and the fostering of full-reproductive cycle farms have converged in the recovery of the species. This is attested by its confirmed presence in its whole geographic range (in historic localities, in localities where it was heavily hunted, and with abundances comparable to those of other crocodile species considered as common).

Efforts for conservation in Guatemala and Belize also show promising results for the long-term conservation of this important reptilian species. Mexico will keep a steady pace towards this goal and will increase efforts, where and when needed, to ensure that extinction danger would not linger again on this species.

Today, in view of the evidence discussed in this document, permanence of *Crocodylus moreletii* as an Endangered species in the list of the U.S. ESA is no longer justifiable. The results of field surveys, and the scientific analysis of the data thus compiled, support the present petition of removal of *Crocodylus moreletii* from its current status in the ESA, and its updated consideration under the following status codes:

DM (Delisted Taxon, Recovered, Being Monitored First Five Years); and

DP (Delisted Taxon, Discovered Previously Unknown Additional Populations and/or Habitat)

This full change is petitioned, and not only its transfer to Threatened status, because present data (biological, ecological, commercial, legal and administrative) clearly indicate that *Crocodylus moreletii* is not currently under risk at the global scale.

Removal of *Crocodylus moreletii* from the Endangered and Threatened species list of the ESA will undoubtedly contribute to give more congruency to the international framework for the conservation of the species (since the IUCN and the Mexican NOM-059 no longer consider this taxon as Endangered nor as Threatened).

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IX. Annexes

The six accompanying Annexes contain more information about the results of several indagations performed to assess the status of *C. moreletii*. These include reevaluation of the status of the species with the IUCN and the Mexican MER (NOM-059) criteria, and several legal and administrative aspects of conservation and sustainable use of the species.

Annexes are:

Annex 1 - Reevaluation of the risk category assignable to *C. moreletii* under the current criteria of the IUCN.

Annex 2 - Reevaluation of the current status of *C. moreletii* under the criteria of the official MER (Risk of Extinction Evaluation Method), included in the Mexican Official Norm NOM-059-SEMARNAT-2001.

Annex 3 – The Mexican legal framework, as related to conservation and sustainable use of *C. moreletii*.

Annex 4 – List of participants from the technical "Workshop for the review of wild populations status of *Crocodylus moreletii* in Mexico and evaluation of the appropriateness to propose its deletion from the U.S. Endangered Species Act", that was held in CONABIO, Mexico City (December 1 and 2, 2004).

Annex 5 - Raw field data obtained for Mexico by the COPAN Project; the main basis of the various analyses performed.

Annex 6 - Conservation actions in Mexico in support of the continuing recovery of *C. moreletii*